BANGALORE ELECTRICITY SUPPLY COMPANY LIMITED

(Wholly owned by Government of Karnataka Undertaking)

TECHNICAL SPECIFICATIONS FOR NEW INSULATING OIL - UNINHIBITED(U) Type- II TRANSFORMER OIL

THIS SPECIFICATION COVERS FOR THE MANUFACTURE TESTING AT MANUFACTURERS WORKS AND SUPPLY OF TRANSFORMER OIL

1.0 SCOPE :

1. The specification covers manufacturing, sampling, testing, packing, marking and delivery of premium grade Unused Mineral Insulating Oil **(Type-II)** for Transformers.
2. This specification prescribes the requirements of new insulating oil suitable for use as an insulating and heat transfer medium.
3. The Unused Mineral Insulating Oils are obtained by distillation and refining of crude petroleum.
4. The Unused Mineral Insulating oils shall be with normal oxidation resistance.

2.0 SERVICE CONDITIONS:

A) The Unused Mineral Insulating oil to be supplied against this specification shall be suitable for satisfactory continuous operation of power and distribution transformers under the following tropical conditions.

1	Location	BESCOM Area Karnataka
2	Max. ambient air temperature	50° C
3	Max. daily average air temp.	40° C
4	Minimum ambient air temp.	10° C
5	Altitude	1000 M above MSL
6	Maximum Wind Pressure	150 Kg/MSq
7	Relative Humidity	10 to 100%
8	Isoceranic level	5° C (Min.)
9	Avg. annual rainfall	As per IS:45
10	Avg. number of rainy	1450 Sq.mm.
11	Climate	Tropical Moderately hot and humid

B) The climatic conditions are prone to wide variations in ambient conditions and hence the Unused Mineral Insulating oil shall be of suitable for satisfactory continuous operation of power and distribution transformers.

3.0 REFERENCE STANDARDS:

3.1 Unless otherwise specified, the Unused Mineral Insulating oil to be supplied shall be conformed to Indian and International Standards amended up to date as follows:

Sl.No	IS No	Title
1	335/2018	New Insulating Oils - Specification (fifth revision)
2	1070 : 1992	Reagent grade water – specification (Third revision)
3	1448:[P:10/sec-2] :2013	Methods of test for petroleum and its products : Part 2 Acidity (Second revision)
4	1448:[P:10]: 2013	Methods of test for petroleum and its products : Part 10 cloud point and pour point (First revision)
5	1448:[P:16]: 2014 & 1448:[P:21]: 2012	Methods of test for petroleum and its products: Part 21 Flash Point (closed) by Pensky Martens apparatus (Third revision)
6	1448:[P:25]: 1976	Methods of test for petroleum and its products: part 25 Determination of kinematics and dynamic viscosity (First revision)
7	16084 :2013	Mineral Insulating Oils- determination of kinematics viscosity at very low temperatures.
8	1783:[Part1]: 1983	Drums, large, fixed ends: Part 1 Grade A Drums (Second revision)
9	1783:[Part 2]: 1988	Drums, large, fixed ends: Part 1 Grade A Drums (Third revision)
10	4759:1984	Hot-dip zinc coatings on structural steel and other allied products (Second revision)
11	6103:1971	Methods of test for specific resistance (resistivity) of electrical insulating liquids
12	ASTMD 971	Methods of test for interfacial tension of oil against water by the ring method.
13	6262:1971	Method of test for power factor and dielectric constant of electrical insulating liquids.
	16086 : 2013	Insulating liquids – determination of the dielectric dissipation factor by measurement of the conductance and capacitance – test method.
14	6272:1971	Metal polishes (special)
15	6792:1992	Method for determination of electric strength of insulating oils
	6792:2017	Insulating liquids – determination of the breakdown voltage at power frequency – test method (second revision)
16	6855:2017	Method of sampling for liquid dielectric (second revision)
17	12177:1987	Methods of test for oxidative ageing of electrical insulation of petroleum oils by the open beaker method
18	12463:1988	Inhibited mineral insulating oils
19	IEC 60814/1997	Determination of water in insulating liquids and in oil-impregnated paper and press board by automatic coulometric Karl Fischer titration – Method of test
20	13631:2017	Method of test for detection and determination of antioxidant additives in insulating oils.(Revision-I)

3.2 In case of conflict arising out due to variations between the applicable standard and the standards specified herein the provisions of this specification should prevail.

4.0 GENERAL TECHNICAL REQUIREMENTS:

The characteristics of the Unused Mineral Insulating oil when it is sampled at manufacturer's work or at the point of delivery and tested in accordance with the methods referred to and shall fully comply with the requirements specified in TABLE-1 & 2 of IS: 335: 2018 and amendments thereof.

FUNCTION :-

i) The Viscosity of Unused Mineral Insulating oil shall be **maximum 15 (mm^2/sec)** at 40°C as per IS 1448 [P:25]:1976.

ii) The Viscosity of Unused Mineral Insulating oil shall be **maximum 1800 (mm^2/sec)** at 0°C as per IS 1448 [P:25]:1976.

iii) Pour Point of the Unused Mineral Insulating oil should be minimum 10°C below the Lowest Cold Start Energizing Temperature (LCSET) i.e. **- 10°C** as per IS: 1448 [P:10. Sec 2]:1970.

iv) The Water content in the Unused Mineral Insulating oil shall be maximum **30mg/kg** for bulk supply and **40mg/kg** for delivery in drums as per IEC: 60814**.**

v) As per IS 6792:1992 the Breakdown voltage of Unused Mineral Insulating oil shall be as follows.

a) The Breakdown voltage of Unused Mineral Insulating oil should be minimum **30KV (rms) at.2.5 mm gap.**

b) The Breakdown voltage of **before Laboratory treatment** should be minimum **70KV (rms) after Laboratory treatment at 2.5 mm gap.**

vi) The Density of Unused Mineral Insulating oil shall be **max 0.895g/ cm^3 at 20°C** as per IS 1448 [P:16]:1990.

vii) As per IS: 16086 the Dielectric Dissipation Factor (DDF) of Unused Mineral Insulating oil shall be maximum **0.005** (Tan-Delta) at 90°C.

viii) Particle Content in drum at delivery of the Unused Mineral Insulating oil is as per IS : 13236.

4.1 REFINING / STABILITY :-

i) The appearance of the Unused Mineral Insulating oil shall be clear, free from sediments (impurities) and suspended matter.

ii) The Unused Mineral Insulating oil should be Neutral and free from any acidic compound. Total Acidity of Unused Mineral Insulating oil shall be maximum **0.01 mg/KOH/gm** as per IEC : 62021 – 1.

iii) Interfacial tension of the Unused Mineral Insulating oil shall be minimum 40mN /m as per ASTM D971.

iv) Total sulphur content in the Unused Mineral Insulating oil shall be maximum 0.05 % before oxidation test as per ISO 14596 or ASTM D4294.

v) The Corrosive Sulphur in the Unused Mineral Insulating oil shall be **Non-Corrosive**. The Corrosive Sulphur in the Unused Mineral Insulating oil shall be measured as per DIN 51353.

vi) The Potential Corrosive Sulphur in the Unused Mineral Insulating oil shall be **Non- Corrosive**. The Potential Corrosive Sulphur in the Unused Mineral Insulating oil shall be measured as per IS : 16310.

vii) Dibenzyl Disulfide (DBDS) in the Unused Mineral Insulating oil should not be detectable (< 5 mg / kg) as per IS : 16497 (Part 1).

viii) The Unused Mineral Insulating oil should be uninhibited (U) as per IS : 13631 / IEC : 60666. Inhibited in the Unused Mineral Insulating oil should not be detectable (< 0.01 %) as per IS : 13631 / IEC : 60666.

ix) Metal Passivator additives in the Unused Mineral Insulating oil should not be detectable (< 5 mg / kg) as per IS : 13631 / IEC : 60666.

x) Oxidation Stability can be improved by incorporation of Antioxidant additive in the Unused Mineral Insulating oil. Oxidation Stability is measured in accordance with IS : 12422.

xi) Furfural and related compound content in the Unused Mineral Insulating oil should not be detectable (< 0.05 mg / kg for each individual compound) as per IS : 15668.

4.2 PERFORMANCE :-

i) Oxidation Stability can be improved by incorporation of Antioxidant additive and metal passivator additives in the Unused Mineral Insulating oil. Oxidation Stability is measured in accordance with IS : 12422 with Test Duration 164 hrs. At the end of Oxidation Stability Test following limits should be observed:

   a. Total acidity: **Maximum 1.2 mg KOH / gm.**
   b. Sludge: **Maximum 0.8 %.**
   c. Dielectric Dissipation Factor (DDF) at 90°C **: Maximum 0.500.**

ii) Gassing Tendency is caused in equipment with high electrical field stress or special design, gasses formed when subjected to Corona Partial Discharges and shall be absorbed by the Unused Mineral Insulating oil, Gassing Tendency shall be as per IEC: 60628, Method A.

iii) Stray Gassing means production of gasses such as hydrogen, hydrocarbons carbon oxides at low temperatures (< 120°C) without thermal or electrical faults in transformer, sometimes even without operational stress. This phenomenon could result in high production of gases and a misinterpretation of Dissolved Gas Analysis (DGA) results.

4.3 HEALTH, SAFETY AND ENVIRONMENT (HSE) :-

i) Flash point of the Unused Mineral Insulating oil measured by Pensky Marten apparatus shall be **minimum 135°C** as per IS: 1448 [P:21]:1992.

ii) Polycyclic Aromatics (PCA) content of the Unused Mineral Insulating oil detectable by extraction with Dimethylsulfoxide (DMSO) under the condition of IP 346, shall be **maximum 3% .**

iii) Polychlorinated Biphenyls (PCB) content of the Unused Mineral Insulating oil **should not be detectable (< 2 mg / kg) as per IS : 16082.**

iv) Electrostatic Charging Tendency (ETC) of the Unused Mineral Insulating oil is an important for certain design of HV transformer which have oil pumping rates that can give rise to the build- up of electrostatic charge. This can result in energy discharge causing transformer failure. Electrostatic Charging Tendency **(ETC)'s measurement as per CIGRE Technical Brochure 170.**

5 ISI CERTIFICATION MARK FOR UNUSED MINERAL INSULATING OIL:-

The Unused Mineral Insulating oil is to be supplied confirming to IS-335-2018 as amended upto date should bear ISI certification mark, without ISI mark insulating oil will rejected.

6 PACKING

6.1 The Unused Mineral Insulating oil shall be delivered in a Non- Returnable clean new steel barrels (drums) of 210 liters nominal capacity conforming to Grade "A" type 2 conforming IS:1783 (Part-1) : 1993 amended upto date. **The drum shall be effectively sealed immediately after filling the oil to avoid ingress of moisture**.

6.2 Consequent on the tendency for water absorption to occur and for the electrical characteristics in oils stored in drums, the limit for power factor, resistivity and electric strength for oil stored in drums shall apply only to oil delivered in India and tests shall conduct within two weeks of delivery.

6.3 STEEL BARRELS:

The steel barrels shall be of 210 liters nominal capacity conforming to grade "A" type-2 conforming IS:1783 (Part-1) : 1993 amended upto date. The type–2 drums of sheets of nominal thickness 1.25 mm for body and ends, with end seam of spiral/triple seam construction The drum shall be coated from inside with epoxy lacquer of phosphate coating or better. The inside coating of the drum shall be resistant to Unused Mineral insulating oil. The outside surface of the drum may be coated with anticorrosive primer and finish paint, for protection against atmospheric corrosion. The colour of the finishing paint shall be Navy Blue (Shade No. 106) conforming to IS:5:1994 (Colours of ready mixed paints)

6.4 MARKINGS :

Each barrel /drum shall be indelibly marked with the following:

a) Manufacturer's name and trade mark.
b) Quantity in liters'.
c) Name of the Material.
d) The words Type II Transformer oil, Uninhibited(U) .
e) Identification in code or otherwise to enable the date and lot of manufacturer to be traced back to the factory records.
f) The Container shall also be marked with IS certification mark, Letters **BESCOM P.O. No. and Date**

7 TESTS:

The tests shall be carried out in accordance with the test method referred in Clause-6 of IS:335 of 2018

7.1 The supplier shall submit the type test reports carried out as per Table -2 of IS:335 of 2018 with upto date amendments or equivalent international standard at CPRI/ERDA/BIS recognized NABL Accredited Govt. Labs and the date of type test shall not be older than 5 years.

Table -2 of IS: 335-2018			
Sl. No.	**Property**	**Test Method**	**Limits of Type II**
A Function			
1	Viscosity at 40°C	IS 1448 (Part 25)	15mm²/s, Max
2	Viscosity at 0°C	IS 1448)Part 25)	1800mm²/s, Max
3	Pour Point	IS 1448 (Part 10/Sec 2)	-10°C, Max To be based on LCSET refer Table 1
4	Water content	IEC 60814	BULK 30mg/kg [3] Max
			DRUM 40mg/kg, [4] Max
5	Breakdown Voltage	IS:6792	As Delivered 30kV, Min
			After Treatment 70kV Min
6	Density at 20° C	IS 1448 (Part 16)	0.895g/ml, Max
7	DDF at 90°C (Dielectric Dissipation factor)	IS 16086	0.005 Max
8	Particle content	IS 13236	No general requirement
B Refining/Stability			
9	Appearance	-	Clear, free from sediment and suspended matter
10	Acidity	IEC 62021- 1	0.01 mg KOH/g, Max
11	Interfacial tension	ASTM D971	No general requirement[6](min 40mN/m)
12	Total sulphur content	ISO 14596 or ASTM D4294	No general requirement
13	Corrosive sulphur	DIN 51353	Not Corrosive
14	Potentially Corrosive sulphur	IS 16310	Not Corrosive
15	DBDS	IS 16947 (part 1)	Not detectable (< 5 mg/kg)
16	Inhibitors according to IS 13631/IEC 60666	IS 13631	(U) Uninhibited Oil: not detectable (<0.01%)
			(T) Trace inhibited oil: <0.08%
			(I) Inhibited oils: 0.08% -0.40%
			(As per clause 3.6 to 3.8 of IS-335 -2018)
17	Metal passivator additives according to IS 13631/IEC 60666	IS 13631	Not detectable (< 5 mg/kg), or as agreed upon with the purchaser
18	Other additives		As per clause 7 of IS 335-2018

19	2 Furfural and related compounds content	IS 15668	Not detectable (<0.05 mg/kg) for each individual compound)
C Performance			
20	Oxidation stability	IS 12422 (Method C) Test Duration [11] (U) Uninhibited oil : 164h	For oils with other antioxidant additives and metal passivator Additives (see 6.12)
a)	Total acidity	1.9.4 of IS 12422	1.2m KOH/g Max
b)	Sludge	1.9.1 of IS 12422	0.8% Max
c)	DDF at 90°C	1.9.6 of IS 12422	0.500, Max
21	Gassing tendency	IEC 60628, Method A	No general requirement
22	ECT	See 6.14	No general requirement
D Health, Safety and Environment (HSE)			
23	Flash Point	IS 1448 (Part 21)	135° C, Min
24	PCA content	IP 346	3% Max
25	PCB Content	IS 16082	Not detectable (<2 mg/kg)

7.2 The supplier should get approved the GTP of Unused Mineral insulating oil and drum from BESCOM QS&S section prior to commencement of the supply.

8 PRE DISPATCH INSPECTION :

The supplier should arrange for sample type testing of Unused Mineral Insulating oil during the contractual period, at their cost. Sample type test shall be arranged as and when directed by the BESCOM at CPRI, Bangalore/ERDA/ BIS recognized Govt. Laboratories.

9 SAMPLING :

The sample shall be taken and tested from each lot for ascertaining the conformity of the lot as per the standards. Sampling of Unused Mineral Insulating oil shall be done in accordance with IS 6885: 2003. The number of drums to be selected at random from a lot shall depend on the size of the lot and shall be as given below:

Sl.No.	No. of Drums in a LOT/Batch	No. of drums from which samples to be taken
1	2 to 5	2
2	6 to 20	3
3	21 to 50	4
4	51 to 100	7
5	101 to 200	10
6	201 to 400	15
7	401 and above	20

10 ROUTINE AND ACCEPTANCE TEST :

The supplier should have adequate testing facility for conducting all the routine and acceptance tests on Unused Mineral Insulating oil. The supplier should submit the list of testing equipments available along with the valid calibration certificate.

The routine and acceptance test shall be conducted as per table -2 of IS:335 of 2018 and it's amendments thereon. The acceptance test shall be conducted in the presence of representatives of the BESCOM. The supplier shall give 15 days advance notice for inspections for witnessing of tests by the purchaser or his representative.

11 REJECTION :-

Apart from rejection due to failure in testing of Unused Mineral Insulating oil to meet the specified test requirements the Unused Mineral Insulating oil shall be liable for rejection on any one of the following reasons.

i) If tests are not carried out as per clause no. 7.0 of this specification.
ii) If GTP parameters are not submitted as per clause no. 4.0 of this specification.

12 QUALITY ASSURANCE

1. Names of the supplier for the raw material, list of standards as per QAP to which the raw materials are tested, list of test normally carried out on raw materials in presence of supplier representatives, copies of test certificates.
2. Information and copies of type test certificate carried out at CPRI/ ERDA/ Govt. NABL labs
3. List of manufacturing facilities available.
4. List of areas in manufacturing process where stage inspection are normally carried out for quality control and details of such tests and inspections.
5. List of testing equipments available for conducting acceptance and routine tests specified in the relevant standards and as per agreement between BESCOM and supplier.
6. The supplier shall submit the Routine Test Certificate along with documents of raw materials viz Crude Petroleum, at the time of Testing.

GTP FOR UNINHIBITED Type II TRANSFORMER NEW TRANSFORMER OIL				
Sl. No.	**Property**	**Test Method**	**BESCOM Requirement**	**Supplier offer**
A Function			**Type II**	
i	Viscosity at 40˚C	IS 1448 (Part 25)	15mm²/s, Max	
ii	Viscosity at 0˚C[1]	IS 1448)Part 25)	1800mm²/s, Max	
iii)	Pour Point	IS 1448 (Part 10/ Sec 2)	_10˚C, Max To be based on LCSET refer Table 1[1]	
iv)	Water content	IEC 60814	In Bulk - 30mg/kg Max	
			Drum 40mg/kg , Max	
v)	Breakdown Voltage	IS6792	As delivered 30kV, Min	
			After Treatment 70kN	
vi)	Density at 20˚ C	IS 1448 (Part 16)	0.895g/ml, Max	
vii)	DDF at 90˚C(Dielectric Dissipation factor)	IS 16086	0.005, Max	
viii)	Particle content	IS 13236	No general requirement[10]	
B Refining/Stability				
ix)	Appearance	-	clear, free from sediment and suspended matter	
x)	Acidity	IEC 62021- 1	0.01 mg KOH/g, Max	
xi)	Interfacial tension	ASTM D971	No general requirement (min 40mN/m)	
xii)	Total sulphur content	ISO 14596 or ASTM D4294	No general requirement	
xiii)	Corrosive sulphur	DIN 51353	Not Corrosive	
xiv)	Potentially Corrosive sulphur	IS 16310	Not Corrosive	
xv)	DBDS	IS 16947 (part 1)	Not detachable (< 5 mg/kg)	
xvi)	Inhibitors according to IS 13631/IEC 60666	IS 13631	(U) Uninhibited Oil : not detectable (<0.01%)	
			(T) Trace inhibited oil: <0.08%	
			(I) Inhibited oils: 0.08% - 0.40%	
			(see 3.6 to 3.8)	
xvii)	Metal passivator additives according to IS 13631/IEC 60666	IS 13631	Not detectable (< 5 mg/kg), or as agreed upon with the purchaser	
xviii)	2 Furfural and related compounds content	IS 15668	Not detectable (<0.05 mg/kg) for each individual compound)	
C Performance				
XX	Oxidation stability	IS 12422 (Method C) Test Duration [11] (U) Uninhibited oil : 164h	For oils with other antioxidant additives and metal passivator Additives (see 6.12)	
a)	Total acidity [9]	1.9.4 of IS 12422	1.2m KOH/g Max	

b)	Sludge [9]	1.9.1 of IS 12422	0.8% Max	
c)	DDF at 90°C[9]	1.9.6 of IS 12422	0.500, Max	
xxi)	Gassing tendency	IEC 60628, Method A	No general requirement	
xxii)	ECT	See 6.14	No general requirement	
D Health, Safety and Environment (HSE)				
xxiii)	Flash Point	IS 1448 (Part 21)	135° C, Min	
xxiv)	PCA content	IP 346	3% Max	
xxv)	PCB Content	IS 16082	Not detectable (<2 mg/kg)	

Supplier/Manufacturer Seal & Signature